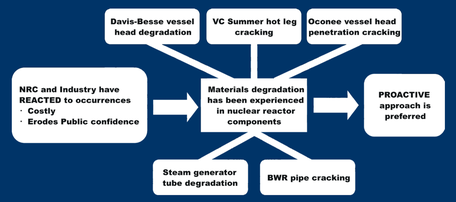
Proactive Materials Degradation Management

Office of Nuclear Regulatory Research, U.S. Nuclear Regulator Commission, Washington, DC, USA

Why is NRC Working on Proactive Materials Degradation management (PMDM)?



- Allow age-related materials degradation to be corrected before significant challenges to structural integrity and safety arise.
  - Mitigation or prevention of the potential degradation could be considered
  - Inspection and monitoring: Detect degradation, follow its growth, repair or replace the components before the degradation impairs structural integrity or safety
- Expert elicitation to identify components susceptible to future degradation
  - PIRT-like process with an 8-member international expert panel (PMDA PIRT)

Proactive Materials Degradation Assessment – PIRT Expert Elicitation

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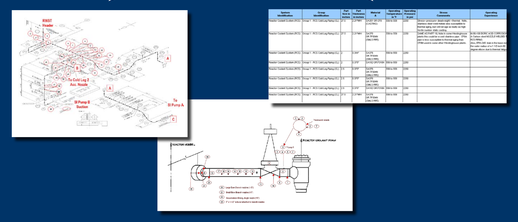
Phase 1

Select components, associated characteristics, and operating environment to be evaluated



Phase 2

Expert panel evaluated potential degradation mechanisms

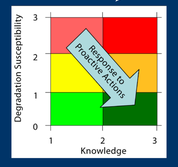
Susceptibility Factor
Can significant material degradation develop given plausible conditions?
Blank = not evaluated by expert
0 = not considered to be an issue
1 = conceptual basis for concern from data, or potential problems under unusual operating conditions, etc.
2 = strong basis for concern or known but limited plant problem
3 = demonstrated, compelling problem or multiple plant observations

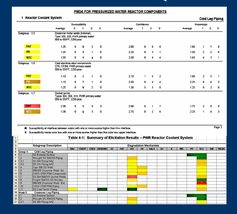
Knowledge Level
Extent to which the relevant dependencies have been quantified
1 = poor understanding, little and/or low-confidence data;
2 = some reasonable basis to know dependencies qualitatively or semi-quantitatively from data or extrapolation in similar "systems";
3 = extensive, consistent data covering all dependencies relevant to the component, perhaps with models -- should provide clear insights into mitigation or management of problem

Confidence Level
Personal confidence in the judgment of susceptibility
1 = low confidence, little known about phenomenon;
2 = moderate confidence;
3 = high confidence, compelling evidence, existing problems

Phase 3

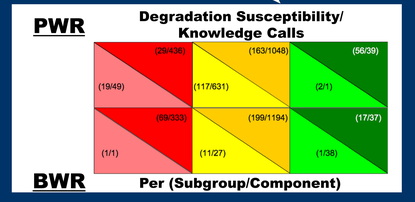
Allow for Identification of components for PMDM programs





Phase 4

Identify Research Needs to Allow for PMDM
- Generic
- Component Specific



For **PWR** Evaluation:
- Started with 48 subsystems containing 2203 components
- Agglomerated into 392 subgroups
- Conducted 1222 Assessments (per expert) for various mechanisms and subgroups

For **BWR** Evaluation:
- Started with 28 subsystems containing 1660 components
- Agglomerated into 297 subgroups
- Conducted 1322 Assessments (per expert) for various mechanisms and subgroups

What are the Next Steps?

International Cooperative Research Group

Regulators, Industry, Laboratories, and Universities
Research topics will include:
-Mechanisms and Materials
- In-service Inspection and Continuous Monitoring Effectiveness
- Mitigation, Repair and Replacement Effectiveness

In-Service Inspection Effectiveness for Detection of Degradation

Find flaw before 75% through wall:
- Use probability of detection to determine size of undetected flaws after inspection
- Use crack growth rate to define time to 75% through wall
- Compare time to 75% through wall to the inspection interval

Risk Analyses

Identify the risk importance of passive component failure:
- Use Red and Yellow components to define CCDP using SPAR Models
- Use fracture mechanics models to estimate POF for components (and degradation mechanisms) with higher risk importance (CCDP)
- Conduct detailed PRA for components with high risk importance and susceptibility using calculated POF

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